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STATION AUTOMATION

BY

MERRICK E. SHAWE

APRIL 1966

GODDARD SPACE FLIGHT CENTER

GREENBELT, MARYLAND

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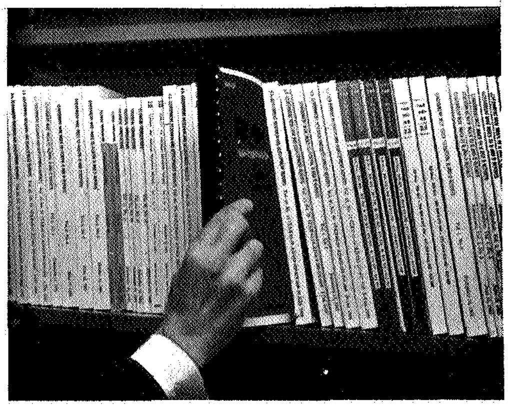

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STATION AUTOMATION

by
Merrick E. Shawe

As the number in complexity of satellites continue to increase, the pointwill be reached where stations will be overwhelmed. Double facilities are already being provided at critical stations such as Rosman and Fairbanks. Some switching techniques are being incorporated to make better use of the equipment. It is felt that by judicious use of automatic equipment to supplement man in some repetitious tasks, station operations may occur more swiftly and passes be handled more efficiently resulting in greater station capacity with little added manpower.

Automation as used herein follows Webster's definition: 'Automatically controlled operation of an apparatus or system by mechanical or electronic devices that take the place of human organs of observation, effort, and decision." There are a number of possible automated operations listed on the attached Table 1.

TABLE 1

Automated Operations

- Station Switchover (30 sec)
- Station Pre-pass Checkout
- Satellite Pass
  - Tracking
  - Data Recording
  - Spacecraft Status Analysis
  - Spacecraft Commanding
- Station Post-Pass Checkout
- Station Input/Output
  - Scheduling
  - Equipment Status
  - Mission Control (OPPLANS)
  - Emergency Control
  - Data Transmission
- Station Maintenance

Station switchover, presently 15 minutes, might be reduced to 30 seconds. After the switchover has occured equipment configuration and status can be verified by means of a station pre-pass checkout. During the satellite pass functions such as tracking, data recording, spacecraft status analysis, and spacecraft commanding proceed handling large amounts of data, but in many cases require a minimum of human intervention. Upon completion of a pass, the station performance may again be evaluated in a post-pass checkout. Many of the station input/output functions are perfunctory. Station scheduling needs to be communicated and listed; equipment status determined and transmitted *to* OPSCOM; mission control translated to action; emergency control inserted into operation plan; and all types of data transmitted with minimum error between central and remote stations. Station maintenance can be scheduled and performed using the switching system and simulators for connection of various equipments and generation of standard waveforms.

If automation is applied discriminately to STADAN and control centers, what advantages and disadvantages might accrue? These are listed on Table 2. Note the apparent conflict between higher station reliability as an advantage and lower station reliabiltiy as a disadvantage. Higher station reliability can occur as a result of improved testing techniques, components, maintenance

TABLE 2

<u>Advantages</u>

- Rapid
  - Switchover via Central Control
  - Test and Calibration
  - Status Interrogation & S/C Mission Control
  - Data Logging
- Multimission Capability & Flexibility
- Combined Functions: Command & **R** and R tones
- Higher Station Reliability?
- Lower $ Per Pass?
- Evolution from DAF

<u>Disadvantages</u>

- Multiple Complex Equipments
- Added Control & Swtiching Devices
- Lower Station Reliability?
- Increased Design and Installation $

procedures, and elimination of some duplicate equipments or functions e.g. tone generation 1. Command Tones 2. Range & Range Rate Tones 3. PFM Simulator Tones. However, lower station reliability can occur since automated equipment is likely to be more complex. Lower dollars per pass has a question mark after it because this cannot be proven until a reasonable configuration is achieved and tested and a cost-analysis study is made of the station configuration. Although the design and installation costs are likely to be higher, it is felt that since more passes can be taken with the same equipment, the dollars per pass will be lower.

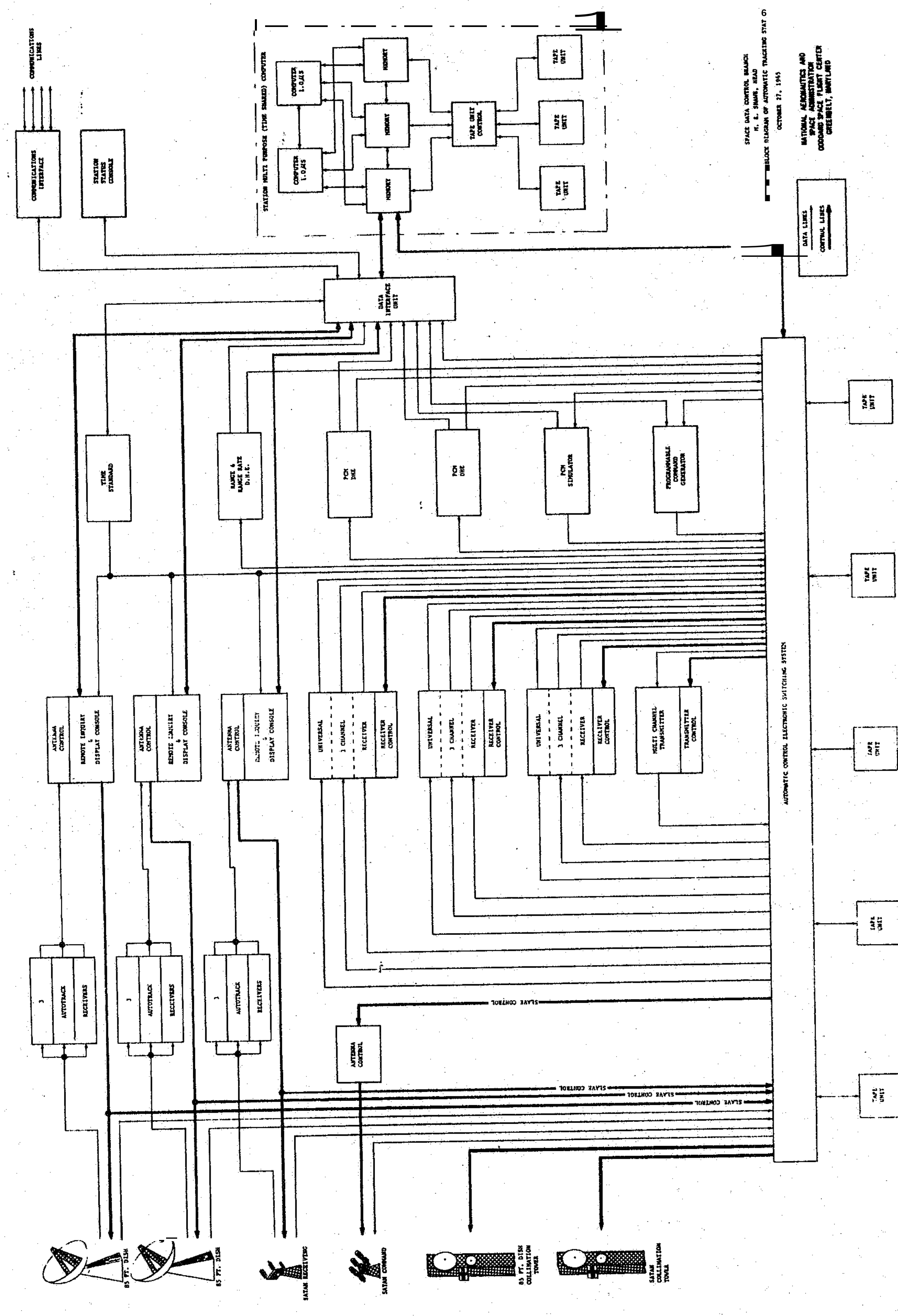
If station automation is to be applied successfully, an approach must be made to assure that sufficient discrimination and judgment is applied in the planning phases. Table 3 shows what evolutionary steps must take place. So far a series of SRT/ART tasks in the Advanced Development Division are attacking items 1, 2, and 3. There is a cooperative effort in the Advanced Development Division and across division lines being applied to items 1, 2, 3, and 4. An advanced ground station study with Operations Research, Inc. is helping with items 1, 2, 3, and 4 using the mathematical technique of Operations Research. These efforts are <u>only</u> <u>scratching</u> <u>the</u> <u>surface</u> and require a considerable coordinated effort in the Tracking and Data area before design of a flexible configuration can proceed.

As a starting point the attached tentative block diagram of an automatic tracking station was prepared. This is simply a compilation of equipment, well within the present state-of-the-art, put together in a form which will automate a great many operations by the use of an overall time-shared computer. Basically

TABLE 3

<u>Approach</u>

1. Examine Present Stations	←
2. Examine Hardware Under Development	
3. Examine Mission Requirements	Allocate
4. Develop System Philosophy	← Tasks
5. Design a Flexible Configuration	←


COMMUNICATIONS LINES
COMMUNICATIONS INTERFACE
STATION STATUS CONSOLE
STATION MULTI PURPOSE (TIME SHARED) COMPUTER
COMPUTER 1.0 µS
COMPUTER 1.0 µS
MEMORY
MEMORY
MEMORY
TAPE UNIT CONTROL
TAPE UNIT
TAPE UNIT
TAPE UNIT
DATA INTERFACE UNIT
TIME STANDARD
RANGE & RANGE RATE D.H.E.
PCM DHE
PCM DHE
PCM SIMULATOR
PROGRAMMABLE COMMAND GENERATOR
ANTENNA CONTROL
REMOTE INQUIRY & DISPLAY CONSOLE
UNIVERSAL
3 CHANNEL
RECEIVER
RECEIVER CONTROL
MULTI CHANNEL TRANSMITTER
TRANSMITTER CONTROL
3
AUTOTRACK
RECEIVERS
SLAVE CONTROL
AUTOMATIC CONTROL ELECTRONIC SWITCHING SYSTEM
TAPE UNIT
85 FT. DISH
85 FT. DISH
SATAN RECEIVING
SATAN COMMAND
85 FT. DISH COLLIMATION TOWER
SATAN COLLIMATION TOWER
DATA LINES
CONTROL LINES
SPACE DATA CONTROL BRANCH
M. E. SHAWE, HEAD
BLOCK DIAGRAM OF AUTOMATIC TRACKING STAT
OCTOBER 27, 1965
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
GODDARD SPACE FLIGHT CENTER
GREENBELT, MARYLAND

the station is connected in an equipment configuration required for a given satellite. The real-time-control loop consists of a receiving antenna receiver, PFM or PCM converter, decision element (man and/or computer), command converter, transmitter, transmitting antenna, and the satellite itself. The entire system is interrogated by means of control and display systems or console where necessary. The main features which allow station automation are the switching system (ACESS) which enables connection of various equipment groups into multiple telemetry lines and a multipurpose computer which performs the control and bookkeeping necessary for the operation but allowing a man to intervene where required. The remote inquiry console is the point where intervention may occur. This console is associated with an antenna to retain the present telemetry line concept. A number of the items are in existence or under procurement, e.g. a first generation switching system, the universal three-channel receiver, the PCM/DHE, the PCM simulator, the programmable command generator, the antenna control, and the multipurpose computer. Station automation is close to a reality! It requires integration of computer control with many existing systems already designed with automation in mind.

The block diagram will be modified by the constructive criticism of persons in the Tracking and Data Area working toward station automation and also by the progress of other programs listed on Table 4. These items particularly demonstrate the interdivision nature of station automation effort.

TABLE 4

Program Problems

Effect of:

1. Data Compression ground/airborne
2. Use of Communications Satellites
3. Mission Changes
4. Network Mergers: Apollo/STADAN
5. Man/Machine Interface Studies
6. Budget Cut Backs

Above all, automation should not be allowed to grow like Topsy with the development effort in one group not used in the program planning of another group, with the operational need of one project being lost in the pressure of another, with isolated thinking in one division causing extra equipment in another, with the segment of automation contributed by one group partially duplicated by or in conflict with that of another.

conflict with that of another.